HUMAN FACTORS DESIGN AND EVALUATION OF A CLOSE PROXIMITY WARNING DEVICE

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One of the largest health and safety concerns in underground coal mining is that of personnel being injured, becoming permanently disabled, or killed by machinery and powered haulage. A total of 24 fatalities were associated with continuous mining machines during a six-year period. Experienced miners are well aware of the inherent dangers of the face area and moving machinery. However, their attention is divided between maintaining production goals, monitoring their own safety, and processing the visual, tactile, and auditory cues that enable them to make informed decisions. The operator may find himself hurried, mentally overloaded, and unable to process necessary information to make these informed decisions. When these circumstances occur, the operator may be exposed to a potentially hazardous situation.

A unique system, identified as HASARD (Hazardous Area Signaling and Range Device), was developed to warn miners when they are in close proximity to the machine. HASARD is composed of two main components: a wireless transmitter that is mounted on a mining machine and one receiver worn by the remote control operator working near the mining machine. The system includes a small antenna which acquires and measures the magnetic field being produced by loop antennas and compares this measurement against two preset levels, calibrated to identify levels of danger. A "WARNING" level indicates that the miner operator is approaching a danger zone. This cautionary zone is a point for the operator to decide to enter the danger zone or return to the safe zone. A "DANGER" level is triggered when the operator actually enters the danger zone. The operator is alerted with a combination of visual (lights) and vibratory (pager-like device) warnings. If necessary, the danger level can be programmed to shut down one or more functions of the machine. These zone distances were varied by the researchers to determine what safe operating distances could be defined without degrading the operator's ability to operate safely and effectively.

This system will be effective only if proper usability tests are completed to ensure its compatibility, integrity, reliability and efficiency. Designers of HASARD were faced with not only the technical equipment operation criteria but also with the integration of human factors principles and current human factors research in this area. The results from research examining operator positioning around remote control mining sections, a review of a competitor system, and data collected from several additional studies at the field test mine, were analyzed to determine the feasibility and reliability of HASARD. Also, the implications of using the HASARD system are investigated. We were able to study miner operators' habits before implementation, after implementation but without operators' knowledge of the system, and again after operators were told how the system works and were given warning signals. Observations, open-ended interviews with miner operators and management, and time-coded positioning data was collected. Operator opinions as to the use and appropriateness of this device is discussed. The results determine the system/equipment/personnel function of HASARD, help determine what design inadequacies need rectified, and establish training and procedure change requirements.

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